DOCUMENT RESUME

ED 244 581 IR 011 076

AUTHOR Campbell, J. Olin; And Others
TITLE Instructional Systems Development Model for Interactive Videodisc. Final Report.
INSTITUTION WICAT, Inc., Orem, Utah.
SPONS AGENCY Army Research Inst. for the Behavioral and Social Sciences, Alexandria, Va.
REPORT NO ARI-RN-83-53
PUB DATE Dec 83
CONTRACT MDA903-78-C-2023
NOTE 50p.; For related documents, see ED 220 071 and IR 011 075.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Authoring Aids (Programing); *Computer Assisted Instruction; *Computer Software; Delivery Systems; Input Output Devices; Instructional Design; *Instructional Development; Man Machine Systems; *Military Training; *Models; Simulation; *Videodisc Recordings; Video Equipment
IDENTIFIERS *Instructional Systems Development Model; Intelligent Videodisc Systems; Interactive Video

ABSTRACT

This third and final report on a 3-year project, which developed authoring and production procedures for interactive videodisc based on the Interservice Procedures for Instructional Systems Development (IPISD), reviews the current state of the art, provides an overview of the project, and describes two videodiscs made for the project and the lessons learned from them. In describing the "Call for Fire" program, the discussion covers packing procedures for including both training and testing on one disc and the main components of the disc: training extension course (TEC) lessons, skill qualification tests, videotape productions, simulation and games, an executive review, an authoring guide, and voice and keypad inputs. Discussion of the RT 524 Alignment Simulation program includes training army personnel in videodisc design, delivery system hardware, the authoring system, and evaluation results. Each block of the IPISD--analyze, design, develop instruction, implement, and control--is described in terms of the new opportunities and requirements of interactive videodisc. Thirteen references and four videodisc-related periodicals are listed. (Author/LMM)

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Research Note 83-53

Instructional Systems Development Model for Interactive Videodisc

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December 1983

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IR011076

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER RN 83-53	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Instructional Systems Development Model for Interactive Videodisc Final Report		5. TYPE OF REPORT & PERIOD COVERED Final Feb 79 - Apr 82
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) J. Olin Campbell, David M. Tuttle, and Andrew S. Gibbors		8. CONTRACT OR GRANT NUMBER(s) MDA903-78-C-2023
9. PERFORMING ORGANIZATION NAME AND ADDRESS WICAT 1875 S. State Orem, UT 84057		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 2Q162722A791
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Research Institute for the Behavioral and Social Sciences 5001 Eisenhower Avenue, Alexandria, VA 22333		12. REPORT DATE December 1983 13. NUMBER OF PAGES 48
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approve for Public Release; Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Videodisc, Interservice Procedures for Instructional Systems Development, IPISD, SAT, Interactive Video, ISD, authoring, Electronic Delivery System, Electronic Information Delivery System

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This is the third and final report on an "Instructional Systems Development Model for Videodisc Training Delivery Systems with Interactive Capability." The report reviews the current state of the art, and describes two videodiscs made for the project, with lessons learned from them. Each block of the Interservice Procedures for Instructional Systems Development (IPISD) is described in terms of the new opportunities and requirements of interactive videodisc. A separate report, "Interactive Videodisc Design and Production Workshop Guide," presents a step by step procedure for making interactive videodiscs.

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UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Table of Contents

Section	Page
DD1473	2
ACKNOWLEDGEMENTS	4
INTERACTIVE VIDEODISC: BACKGROUND	5
PROJECT SUMMARY	9
Purpose and Outcomes	9
Yearly Summaries	11
DESIGN AND PRODUCTION CONSIDERATIONS	15
IPISD Additions and Tryouts	15
Interactive Videodisc Techniques	15
Hardware Tryout	17
Personnel Changes for Interactive Videodisc	19
Videodisc Mastering and Programming	19
Costs	19
Evaluation	20
REVISIONS TO THE INTERSERVICE PROCEDURES FOR INSTRUCTIONAL SYSTEMS DEVELOPMENT (IPISD)	22
Analyze	22
Design	24
Develop Instruction	25
Implement	27
Control (Evaluate and Revise)	28
THE "CALL FOR FIRE" PROGRAM	29
Packing Procedures	29
Training Extension Course (TEC) Lessons	30
Skill Qualification Tests (SQT's)	30
Videotape Productions	31
Simulations and Games	32
Executive Review	32
Authoring Guide	32
Voice and Keypad Inputs	32
THE RT 524 ALIGNMENT SIMULATION PROGRAM	34
Training Army Personnel	34
Delivery System Hardware	38
Authoring System	38
Evaluation Results	39
CONCLUSIONS	46
REFERENCES	47

List of Figures

Figure 1.	Interactive Video: System Hardware	10
Figure 2.	Sample Production Sheet for a Linear Equipment Simulation	36

ACKNOWLEDGEMENTS

The author wishes to thank Mr. Jim Frye, 1LT Sam Palmisano, and SFC Sanford Barshafsky at the Ft. Gordon Videodisc/ Microprocessor Group, who recommended a number of interactive videodisc procedures for equipment simulations. Their procedures are incorporated in several parts of the workshop.

The reviews of Mr. Jim Baker, Dr. Bruce Knerr, and Dr. John Larson at ARI; and of Dr. Andrew Gibbons, Dr. Joseph Lipson, Mr. Gordon Ridd, and Dr. David Tuttle at WICAT are gratefully acknowledged.

INTERACTIVE VIDEODISC: BACKGROUND

As of March, 1982, several interactive videodisc programs have been implemented in the military. A recent report (Stranick and Sullivan, 1982) lists 24 military projects using videodisc. Most of these are for maintenance training and simulation.

Who

The primary military support for videodisc training programs is from the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI), the Army Communicative Technology Office (ACTO), the Naval Training Equipment Center (NTEC), the Naval Personnel Research and Development Center (NPRDC), the U.S. Army Training Development Institute (TDI), the Defense Advanced Research Projects Agency (DARPA), and the U.S. Army Program Manager for Training Developments (PM TRADE).

Trends

Because these programs are just beginning to be implemented, it is too early to determine their effect in the military community. However, a few trends are beginning to appear. Videodisc programs are primarily used for simulations and modeling in the services. Only a few groups in the military are developing their own materials. Some of the leaders among these are personnel from the U.S. Army Signal School and Center at Ft. Gordon. This group has produced three interactive videodisc programs, and consulted on several others. The Department of Defense Agency in charge of overall videodisc developments is the Army Communicative Technology Office (ACTO) at Ft. Eustis, Virginia.

Videodisc Players

Virtually every military videodisc project in process or planned uses the reflective optical videodisc. The reason is that this system offers the ability to stop on any one of 54,000 frames. Videodisc players used include the Pioneer and Magnavox consumer players and the Sony and Pioneer (DiscoVision) industrial players. The primary distinction is that the industrial players are more ruggedly built and contain an internal programming capability, so simple programs can be entered into the videodisc player from the keypad or read in from the videodisc itself.

One of the most important recent developments is still frame audio, by which an audio message can be played along with a still video picture. As of the first quarter of 1982, commercial videodisc players require that a motion sequence be played at 30 frames per second in order to obtain audio. This is often very wasteful. New players and attachments will overcome this handicap with still frame audio.

Computers and Input Devices

A wide variety of computer systems are being used to control these players. The most common are the Apple II, WICAT System 100, and ALTOS 6800. There is currently some rivalry between the 8 bit APPLE- and ATARI-like computers and larger micro-mainframes using 16 or 32 bits and up to several megabytes of random access memory (RAM). At present, 8 bit machines usually cost less. Systems using 16 and 32 bit central processing units (CPU's) can address more memory and thus run larger programs. They may also be more easily programmed and user friendly, since memory space is not such a constraint. Newer 16 and 32 bit CPU's may also run faster. The rivalry is likely to diminish as the price of the new 16 and 32 bit chips declines.

The most common input devices are keyboards, touch screens, and light pens, but almost any input (e.g., voice, biofeedback) can be accommodated.

Mastering

The number of videodisc mastering houses is presently very limited. DiscoVision Associates has stopped work and transferred their orders to Pioneer. Sony continues to master in Japan. Philips has a very limited production capability in Holland, and 3M has begun mastering in the United States. Mastering times continue to be uncertain, and typically range between 6 and 12 weeks. A possible new contender is Quixote Corporation, which demonstrated an early prototype videodisc recently. The videodiscs produced by their process are said to be compatible with other optical reflective discs produced by Pioneer and Sony. The element of prime interest about the Quixote announcement is that their system may be amenable to in-house mastering. This would provide faster turn-around time and would solve the problem of military security. The Optical Recording Project at 3M is working on a TOP SECRET clearance for both facility and personnel, and this may also alleviate the security problem.

Authoring Procedures and Systems

Both WICAT Systems and the University of Nebraska are developing and promulgating videodisc design and development procedures. This report and the accompanying workshop guide present one adaptation of a standard military instructional development process (The Interservice Procedures for Instructional Systems Development -- IPISD). The University of Nebraska has recently produced for 3M a two-sided videodisc program on how to make a videodisc. In addition, both the Naval Training Equipment Center (NTEC) and Ft. Gordon personnel are planning to develop workshops on how to produce interactive videodisc programs.

2D Generic Simulations vs. 3D Replica Simulators

A 3D (three dimensional) replica simulator is custom designed to look and operate as close to the original as possible. Such custom engineering and special parts usually drive up the costs. Moreover, a 3D replica simulator costing millions of dollars can be used for only one major system, and must be re-engineered when that system changes because it is a replica of the system.

On the other hand a 2D (two dimensional) generic simulation system uses two dimensional pictures (usually from videodisc), touch panel, and computer to provide interactions. Simulations for it are usually far less expensive to develop than designing new hardware for a 3D replica simulator. One 2D generic delivery system can provide simulations for many devices and situations by simply changing the videodisc and loading a new program. Through motion and still sequences it provides instruction, and can also present an expert performing a task, as a model of correct procedures. In addition, when hardware changes are made to the actual equipment, a generic 2D system requires only pictures of the new hardware configuration and a new computer program to model it. The simulation system hardware need not be changed, and it is not necessary to wait for a piece of the new equipment to become available for training before training can begin.

A 2D simulation is not very useful for learning component locations. In many cases an inexpensive mockup will serve this purpose. Psychomotor skills such as landing an airplane require 3D replica simulators. However, many of the troubleshooting, communication, and other procedural sk lls now trained on very expensive equipment can be initially practiced on generic 2D systems.

Cost

The cost to develop an interactive disc program is usually much less than for a comparable videotape in terms of cost per user minute, and it is often an order of magnitude less than a 3D replica simulator.

A complete production usually provides from 5 to 20 hours of contact time per side of the videodisc, and costs, with delivery system hardware, about $100 to $700 per contact minute. By comparison, total costs for training videotapes usually range from $2000 to $4000 per minute, without hardware. If the videodisc is used only for motion that could be presented with videotape, the cost is comparable to tape. If the disc is used for presentations with many stills, the cost per contact minute for interactive videodisc can be much lower, since each of the thousands of still frames will likely be viewed for several seconds.

An interactive videodisc used for system simulation, where a complex system is modeled in software, might be costly. However it might replace most or all of the training functions of a 3D replica simulator hundreds of times more expensive.

The Future

The field is gaining momentum. Even with our current technology we can deliver powerful 2D simulations using only the interactive videodisc system, without actual equipment. However, we are just at the beginning. Like early movie producers who simply aimed the camera at actors presenting a play on stage, we are still somewhat limited in our conception of what can be done by the medium. Some of the new games (e.g., the tank gunnery trainer produced for DARPA) and new conceptions of what can be done (e.g., surrogate travel programs) are breaking these limits.

Today, the technology of hardware, videodisc production, and software is sufficiently expensive that most users are in the military or in large corporations. However, computer hardware costs can be expected to continue their decline. Authoring systems will bring the creation of videodisc programs within the realm of smaller developers, while new video storage technologies (such as re-recordable discs and local mastering) may dramatically cut the cost of videodisc production. As this happens, we are likely to see the flowering of a great creative genius within the society as interactive videodiscs begin to follow the route of personal computers, and become commonplace.

It is an exciting period, and one likely to become increasingly diverse as programming moves out of the realm of software specialty groups. The military cannot help but gain by this process, as new ideas, new techniques, and new personnel become available to contribute to one of the largest and most critical training enterprises in the world.

PROJECT SUMMARY

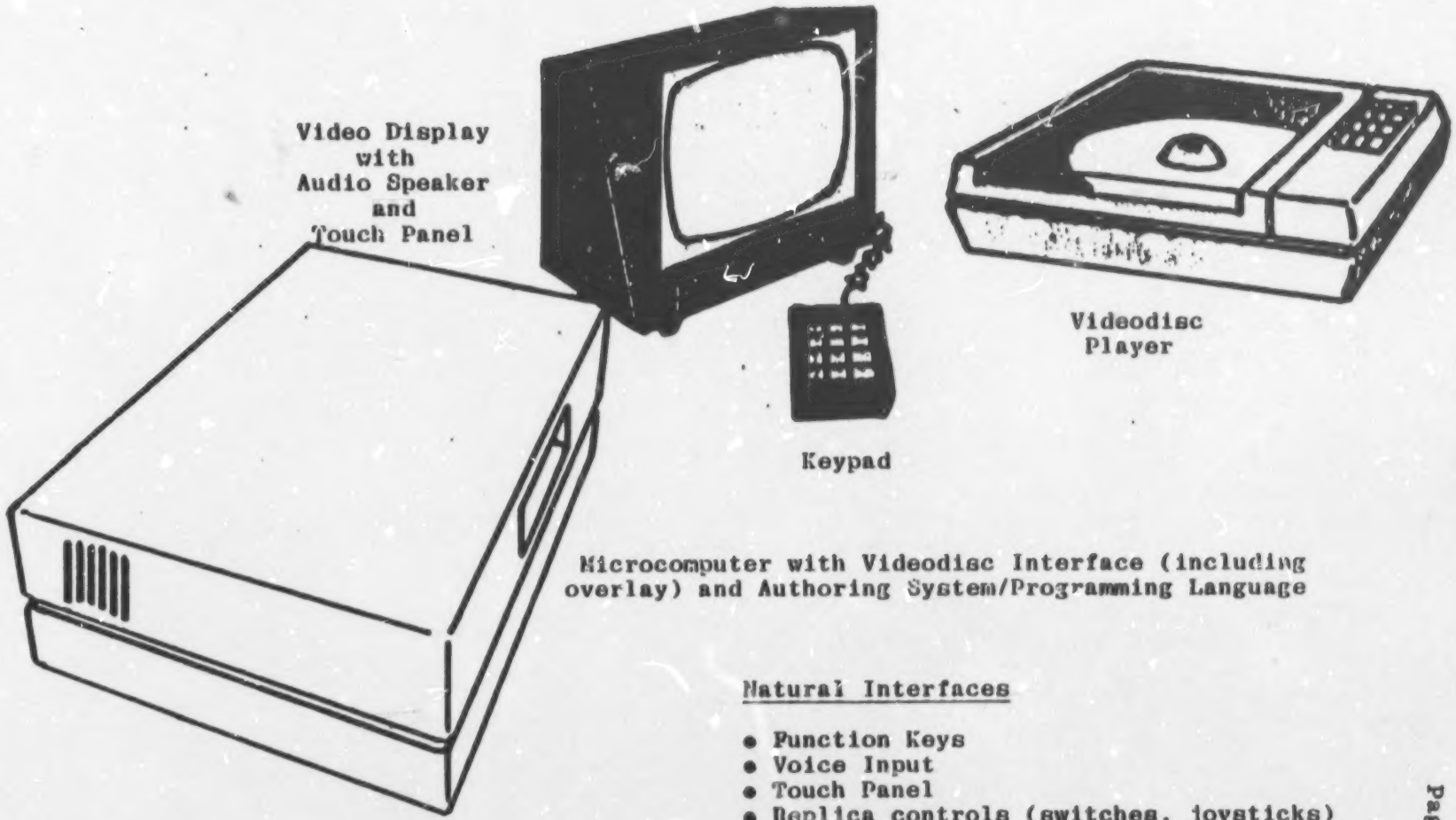
This final report describes the major tasks and results of an extensive project to provide developers of interactive videodiscs with a design/development procedure. The procedure itself is presented in the Interactive Videodisc Design and Production Workshop Guide (Campbell, Tuttle, and Gibbons, 1982). This report describes the methodology and details of two interactive videodisc programs produced, and presents an overview of the findings. It includes sections from earlier reports as well as the results of the third year's research. The workshop provides the "How To."

Purpose and Outcomes

Both the military and industry are currently facing a serious dilemma: The jobs required to run a technology-based organization are often quite complex, but the people who are required to perform those jobs lack the skills necessary for high productivity. The result is large discrepancies between potential and actual performance. One response to this skill deficiency has been to multiply the number and volume of technical manuals, to the point that there is a danger of drowning in a sea of paper. A promising alternative is to present training simulation and job aids on electronic delivery systems. A current system includes a microcomputer and an optical videodisc player to provide a large library of color graphics, audio, and motion. Figure 1 presents a typical interactive (computer-controlled) videodisc system.

While the interactive videodisc hardware is developing, design and development procedures are needed for such a delivery system. The purpose of this three year project is to develop authoring and production procedures for interactive videodisc, based on the Interservice Procedures for Instructional Systems Development (IPISD). These procedures provide an effective standard methodology for developing training. They are widely used in the military, and variations are widely used in industry.

INTERACTIVE VIDEO: SYSTEM HARDWARE



Microcomputer with Videodisc Interface (including overlay) and Authoring System/Programming Language

Natural Interfaces

- Function Keys
- Voice Input
- Touch Panel
- Replica controls (switches, joysticks)

Figure 1

ARI began sponsoring this research on authoring and production procedures for interactive videodisc in 1978. This study was conceived as a three-year effort, the result of which would be that Army personnel and those in the other services would have the following available for preparing interactive videodiscs:

- o Revisions to the Interservice Procedures for Instructional Systems Development covering interactive videodisc
- o Guides and Job Aids for authoring and production
- o Production/Postproduction procedures
- o Mastering guidelines
- o Two interactive videodiscs prepared according to the guidelines
- o Cost estimates based upon the program as produced
- o A set of training materials on how to develop an interactive videodisc
- o A group of trained Army personnel who had actually produced an interactive videodisc according to the guidelines and examples above

All of the above items have been accomplished, and are reported on in the Interactive Videodisc Design and Production Workshop Guide (Campbell, Tuttle and Gibbons, 1982) and this final report.

Yearly Summaries

The project was established in three increments of one year each. The purpose of the first year was to design the system and define procedures for producing interactive videodisc materials. The purpose of the second year was to produce an interactive videodisc using those procedures, and revise them based upon what was learned. The purpose of the third year was to teach the procedures to a group in the Army, provide consultation as they produced an interactive videodisc, evaluate their program, and revise the procedures based on the results. The procedures were incorporated into a workshop for wide dissemination. During the third year of the contract an evaluation of voice input and touch panel usage with interactive videodiscs was made, and a set of guidelines for production and student use of interactive videodiscs with these input devices was prepared. They are presented in the workshop guide.

The overall objective was to concentrate the effort of this project on the authoring and production phases of videodisc development. This was an appropriate choice, since the work clearly indicates that the initial phases of analysis, design and development for the interactive videodisc are similar to those currently in use and presented in the Interservice Procedures for Instructional Systems Development (IPISD). Modifications required

were presented in detail by Bunderson, Campbell, and Farr (1980b). Other perspectives on videodisc authoring are contained in Hawkins and Kribs (1970), the Proceedings of the Society for Applied Learning Technology (SALT) conference on videodisc (SALT, 1979), and "Producing Interactive Videodiscs," developed by the Nebraska Videodisc Design Production Group for 3M (Optical Recording Project/3M, 1982).

Year One

The first year of the project aimed at developing the procedures for interactive videodisc authoring and production, and for selecting and designing the graphics that will be used in the videodisc presentations.

The project began before any videodisc player was commercially available except the Philips/Magnavox. There were no commercially available videodisc interfaces for computers. Therefore, the original goal was to develop a brassboard simulation of an interactive videodisc system. Instead, by the end of the first year an interactive videodisc system was developed, including an interface that reads the frame number from the video information, controls the videodisc player, and places text and graphics overlays on the videodisc image. This interface used the Magnavox player.

Originally, the PLANIT (Programming Language for Interactive Teaching) authoring language was used to control the videodisc on a Texas Instruments TI990/10 minicomputer. Even in a heavily optimized configuration, the system ran too slowly on this microcomputer. Therefore, it was necessary to implement PLANIT on a VAX 11/780 mainframe computer, and this produced excellent results. Following this, a special videodisc machine input/output procedure (MIOP) for PLANIT was developed, so that PLANIT could continue to operate in its normal mode, but its output strings would be interpreted by the videodisc controller and used to run the videodisc player or to put text and graphics on the screen.

The primary drawback to using PLANIT on the VAX was portability. In order to conduct the field evaluation at Ft. Sill, Oklahoma, we had to communicate over telephone lines with a remote computer. While this provided satisfactory performance for the evaluation, it was clear that a reliable and standalone system would require an on-site computer.

During the first year, the possibility of using an author mockup system, to permit authors to develop and try out various pieces and alternative approaches prior to developing the master material for videodisc, was investigated. This approach was rejected for three reasons:

1. Authors usually do not know how to produce the text and graphics themselves, and therefore must rely on other production personnel.

2. Using professional technicians, the cost of mockup was

almost as high as for the actual production, and became prohibitively expensive.

3. Videodisc production is sufficiently similar to standard video and film production that production personnel could already give us many of the answers we needed, and other answers came from related projects.

At the end of the first year the authoring and production procedures had been developed in consultation with video and film personnel. A manual videodisc had been produced, and the results of that production incorporated into the procedures. By the end of the first year there was a working interactive videodisc system and the PLANIT authoring language had been adapted for videodisc control on the VAX 11/780.

Year Two

The focus of the second year was to develop and try out an interactive videodisc using the procedures prescribed in the first year's work. The second year results were used to refine the procedures, to describe the actual costs of preparing the videodisc programs, and to prepare training materials for Army authors to be used during the third year.

The detailed objectives of the second year's study were to:

1. Try out and revise the IPISD additions by making a videodisc.
2. Evaluate techniques such as use of computer-generated text and overlays.
3. Try out the hardware delivery system.
4. Investigate what personnel changes are required.
5. Evaluate videodisc mastering and programming.
6. Determine costs.
7. Conduct a field evaluation of the completed product to assess student interactions and preferences.
8. Based on the above, modify the procedures developed during the first year.

This work was done, and resulted in the videodisc titled, "Call For Fire." This disc was produced in coordination with the U.S. Army Field Artillery School at Ft. Sill, Oklahoma. Six existing Training Extension Course (TEC) lessons were combined with portions of three Skill Qualification Tests (SQT's) and portions of six videotapes to produce the disc. To this were added an executive summary, author training, games, and a simulated Call For Fire exercise.

Year Three

During the third year the effort was supported by Ft. Gordon. Personnel from Ft. Gordon already had a successful videodisc program and were developing others. They used the procedures that had been developed in years 1 and 2 to develop an interactive videodisc program. Consultant support was provided during the development process. Ft. Gordon personnel evaluated the procedures, and their videodisc program was in turn evaluated in terms of the procedures and formats used. A final revision of the videodisc authoring and production training materials (including guidelines, procedures, formats, and job aids) is being made available for other authoring and production groups via a workshop guide (Campbell, Tuttle, and Gibbons, 1982). The procedures used in the third year of the project were based upon the first and second year's effort (Bunderson, Campbell and Farr, 1980a, b; Merrill and Bunderson, 1980, Campbell and Farr, 1981).

DESIGN AND PRODUCTION CONSIDERATIONS

IPISD Additions and Tryout

The introduction of a powerful new delivery system like the interactive videodisc affects a number of blocks in IPISD. The primary contribution of the project to IPISD, however, is to expand greatly Block III.4: "Develop Instruction." While there is a general discussion of audio/visual production in that step, a great deal more detail and guidance is necessary for interactive videodisc authoring and production. This report and the accompanying workshop guide present a series of procedures, guidelines, and job aids that can be adapted to a wide range of videodisc projects. They can help both authors and production personnel to make efficient use of this new delivery system.

It would be a mistake to use the interactive videodisc simply to deliver programmed instruction. While the delivery system is certainly capable of turning pages of an electronic book, it can also deliver highly interactive simulations, games, generative problems, and motion examples of complex procedures as they are performed in the field. One of the challenges to first-time users of interactive videodisc is to think creatively and imaginatively about the possibilities, to experiment and play with the medium, and to move beyond merely transferring workbooks and videotapes onto videodiscs.

In addition to expanding the standard development procedures to include videodisc, another major achievement of the project was the development and tryout of two programs, using the procedures prescribed here. The tryouts revealed that the students were intensely interested in simulations and games with fidelity to the actual job. They were about as interested in workbook presentation via videodisc as they are in workbook presentations by paper -- which is to say they were tolerant, but hardly excited.

Another instructional strategy evaluated during the project was the use of motion examples to permit human modeling via videodisc. The content chosen, calling in artillery fire, can be taught using simple diagrams and procedures. However, it is quite a different matter to carry out this assignment on the battlefield with explosions and other action all around. By showing the soldier performing the job in the field with many of the attendant stimuli (terrain, sound, competition for attention, etc.), it is possible to provide a much closer approximation to the actual job experience, which may facilitate transfer of training to the job.

Interactive Videodisc Techniques

Packing. In addition to the instructional strategies described above, a number of techniques were developed for interactive videodisc and tried out during the project. Among these was high density packing of materials. An earlier study (Bunderson and Jarvis, 1979) conducted for the Army Communicative Technology Office (ACTO) made clear the critical impact of the amount of material

which is packed on each disc in relation to the total cost of the programs for the Army. The cost effectiveness of videodisc programs is directly related to the amount of material packed on each disc.

Still Frame Audio. The biggest contributor to packing will be still frame audio, by which many seconds of audio can be recorded for each single frame on the videodisc. This technology will soon by widely available. Until then, it is useful to decrease the volume of materials by combining common skills into a job training package as described below. We also experimented with the use of both audio channels as simulated still frame audio. When commenting on a single frame of material, the audio could play forward for half of the message on the audio track then double back and play the second audio track. This proved to be very tedious during production. Also, the pauses required to play backward to the beginning of the narration were so long as to be distracting to the student. Therefore, we do not recommend this method for increasing audio time. This is not to denigrate a second language on the second audio track, use of the second audio track with the video blanked to achieve random access audio, or stereo sound.

Text/Graphic Overlays. One of the most critical features of the system used for both ARI videodiscs was computer-generated text and graphics overlays. Since commercial optical videodiscs cannot presently be altered once they have been replicated, the videodisc has an inherent drawback for training materials that must change quickly. On the other hand, computer programs stored on magnetic media can be modified at any time. By permitting the computer program to overlay text and graphics on the screen as well as to control which videodisc image is presented, the advantages of the videodisc for color, motion and audio are combined with the advantages of the computer for flexible programming and updates.

For example, during tryouts we found that one section of the disc needed more explanation. Several computer-generated text pages were added. These solved the problem. As another example, several numbers in one of the complex videodisc frames were shown incorrectly. Computer text was used to overwrite the incorrect portions of the frame with the correct numbers.

Another capability of the text overwrite system is to generate new items on a videodisc background. For example, the videodisc was used to present a highly detailed topographic map with grid lines. The computer then randomly placed graphic symbols on the map corresponding to a target and an observer. The student was required to give the grid locations based upon the map symbols. In this way, one highly detailed videodisc frame can be used for a virtually endless variety of exercises and simulations. The overall effect is to greatly extend the flexibility and useful life of videodisc programs.

One of the most important cost features evaluated was use of existing materials. The "Call for Fire" videodisc integrated segments from many different videotapes, and reformatted materials from six TEC lessons. This demonstrated the feasibility of using

different media sources of inputs for the videodisc, and minimizing new development costs.

Two other techniques used during authoring were computer controlled real-time animation and color-coded frames. Just as it is possible to use the videodisc to slow down a motion sequence in order to study each aspect of a rapidly changing event, it is possible to use the computer to control the rate of presentation of graphic stills. In this way, apparent motion can be achieved at relatively low cost. That is, it is not necessary to go to 30-frame per second cartooning in order to achieve the effect of motion. In some cases a simple alternation between two frames produces enough illusion of motion to illustrate a point and to maintain student interest. Finally, color-coded frames were used to signal what type of information was being presented--new instruction, help frames, and the like. These may be useful to help students understand and control the sequence of presentation.

Hardware Tryout

User Delivery System. The study also permitted a tryout of the hardware. The generic user delivery system, consisting of (a) a computer; (b) touch panel, keyboard, or keypad; (c) videodisc player; (d) interface; and (e) TV monitor can be used to present a wide variety of content using many instructional strategies. As noted above, the strategies range from simple page turning through complex simulations and games. The user delivery system is just starting up the learning curve. It can be expected that advances in microcomputers and videodiscs in the coming years will significantly decrease the costs and enhance the capabilities of this delivery system.

It is necessary that the computer system provide a large random access memory and fast, high capacity magnetic disk storage to support a highly capable authoring system. This increases hardware costs somewhat, but results in considerable software savings.

While a general purpose keyboard can be used for many applications, a touch panel or functional keypad is often easier for students to use, and will often increase efficiency of interactions.

The player used during the second year was a modified Philips/Magnavox unit. This player offers very low cost ($800) but early versions proved not to be rugged enough for military or commercial applications. Investigations indicate that industrial/education players like those made by Pioneer (DiscoVision) or Sony are better for these applications. Even though they are more expensive--$2,000 to $3,000 per player--they have the advantage that computer interface is easy, they are more reliable, and a service network has been developed for them.

The interface unit between the computer and the videodisc can be as simple as one that "pushes the buttons" of the player to one that permits text and graphics overlays. For the reasons stated above, text and graphics overlays are critical. Several interfaces

use a Texas Instruments 9918 chip for this purpose. The chip operates well so long as there is no video input. When there is a video input that must be mixed with the characters generated by the chip itself, there is a noticeable jitter to the characters. More expensive character generator/mixer systems can alleviate this problem.

Production Hardware. Production hardware has evolved during the course of the project. Originally it was anticipated that a fairly complex mockup system would be used, where authors would create materials on their own without the involvement of production personnel. This proved to be inefficient. Instead, it was found that a studio quality character generator to produce the text, coupled with a high quality color television camera and 1 inch Type C videotape recorder were sufficient to develop and review materials during production. Use of this hardware permits in-house reviews and immediate changes of the text as it is prepared. In addition, the camera and videotape player can be used to place visual images on the screen and to align the text where reviewers can screen materials during production and make immediate changes, while the cost is low. A low quality camera and videotape recorder can be used for tryouts, but their use necessitates reshooting onto a higher quality system.

Because of the close interaction of authors and production personnel, the media production facilities should be located physically very close to the authors.

Post-production Procedures. Videodisc post-production corresponds closely to video post-production in a traditional television studio. The primary difference is the addition of a large number of field accurate still frames. In a typical 30-minute videotape production several hundred edits might be made. It is not uncommon to find 600 to 1500 videodisc still frames on one side, and editing them onto the tape one by one is not recommended. The fields within a video frame must not alternate video information, or the videodisc player will combine two different pictures. This is not a problem with motion because the edits flash by so quickly. On a videodisc, however, adjacent frames may be completely different, and the student may stop on a single frame. A computer-controlled videotape editing system, studio quality TV camera, and helical scan videotape recorders are extremely useful. The advantage of helical scan over quad format is that it permits single frames to be examined. In addition, a digital special effects system is very useful. Most television studios provide all of the capabilities above except for consistent field accurate edits, and that may be simply a matter of checking. One additional piece of equipment which may be highly useful is a magnetic still frame storage device. While this device is not required, it may save money for a high volume post-production studio because still frames can be laid in one at a time on the still frame store, then dumped as a block to videotape. Another approach is to use slides or movie film for stills, then transfer them to videotape.

Authoring System. An authoring system is a virtual necessity for large volumes of interactive videodisc development. This project used PLANIT on a VAX 11/780 with a videodisc controller for the Call For Fire program. It also used a custom authoring system for the third year alignment simulation.

Personnel Changes for Interactive Videodisc

Personnel changes (compared to conventional A-V development) required to produce interactive videodisc are minor, based upon our experience with the videodiscs produced. Authors and technicians maintain their same roles, though they must learn to take advantage of student interaction.

The person who must greatly adapt to the new technology is the producer, who must orchestrate the work of authors, subject matter experts, graphics artists, television personnel, and computer programmers. This person must have a vision of how the new interactive medium can be most creatively used. If the producer can convey this vision to the authors and to the production personnel, they can continue to operate basically as they always have. Without that vision, however, the videodisc will simply be used as another workbook or motion-only videotape system.

Videodisc Mastering and Programming

Experience indicates that mastering of videodiscs is still in an early stage of development. Turnaround time from delivery of videotape to return of videodisc replicates ranges from 6 to 12 weeks.

Videodisc programming using a powerful authoring language can be straightforward for most applications. Within an hour, an author can be developing simple computer-controlled videodisc instruction. Complex simulations and generative items must be hand coded by a programmer, however. These are time consuming to program and so must be planned carefully.

Costs

As might be expected from the range of content and instructional strategies, costs for videodisc production vary widely. A typical production which is not pure simulation would cost between $100,000 and $200,000. Since this would account for between 5 and 20 hours of interaction time, the videodisc can be much less expensive than a videotape production for the same amount of student contact time. Shorter videodisc productions that provide an hour or less of interaction are recommended to begin. These can also cost less to develop.

The user hardware includes a TV monitor ($800), player ($2250), and computer with videodisc interface, keyboard, keypad, or touch screen, and magnetic disks. Computer costs depend on the system used, and typically range from $400 to $20,000.

As noted above, an interactive videodisc used for system simulation, where a complex system is modeled in software, might be costly. However, it might replace most or all of the training functions of a 3D replica simulator hundreds of times more expensive.

Evaluation

The second and third year evaluations brought out a number of important factors:

- Military groups can produce interactive videodiscs in-house if top quality video studio and programming resources are available.
- Before any first production, the developers should review other interactive videodisc productions and attend a workshop.
- A high payoff and relatively simple beginning is a linear simulation where the user proceeds through a fixed sequence of actions. A short section should be chosen at first.
- Simulations should be used to provide hands-on experience and to develop student involvement and motivation. Text presentations on video with few graphics are not as motivating.
- A user oriented authoring system can decrease time and costs, especially for large projects.
- Military training programs should be designed for small groups as well as individual use. The interactive videodisc system worked well in small group mode, though it was designed for individual instruction. Faster students helped the slower students. Some of the practice and all of the testing must be presented individually, however.
- The interactive videodisc was rated highest of all instructional media by the students.
- The instruction must be self-explanatory, self-prompting, and forgiving (tolerant of errors).
- Specially labeled function keys or preset touchscreen locations should be used to make interaction easier.
- A glossary of terms and modules should be available at any time in technical training.
- A full-time proctor should start off each group, then fade out and let students take over.
- Graphics overlays need to be stable (without jitter).
- A microcomputer at the training site is more reliable than communication over phone lines to a time-shared computer.

One of the most important items from the evaluations was the high enthusiasm of the students for simulations (as opposed to workbook-like presentations). This delivery system can potentially increase training productivity if used imaginatively to permit the student to gain hands-on experience with the job. This is related to a major observation in the first year final report (Bunderson, Campbell, and Farr 1980b, Vol II): Current ISD procedures are bogged down in a "lexical loop" of text and verbalization-based delivery. Interactive videodiscs offer an alternative: the replication on disc and in computer program form of interactive "work models" with built-in, job-like feedback. The term "work model" is a name applied to simulations that model the work situation the learner will later encounter on the job.

REVISIONS TO THE INTERSERVICE PROCEDURES FOR INSTRUCTIONAL SYSTEMS DEVELOPMENT (IPISD)

This section presents a block-by-block analysis of the changes to IPISD that are made possible by interactive videodisc. It shows how the medium can be used to do things that were not economically possible before.

I. Analyze

I.1 Analyze Job

An important possible addition in Block I.1 is a task analysis by means of computer modeling when required for computer simulations of the job. Designing a simulation forces the issue of "taking into account" every action taken. While the task analysis is typically concerned with what the exemplar performer does on a job and not how it is done, an analysis of sufficient detail to encode it in software is likely to uncover a number of skills which are either taken for granted or completely overlooked by the performer. Clearly this level of detail would not be required for every aspect of a job, but in some cases it may result in a clearer understanding of what is required to perform a task than an interview with the exemplar performer would reveal. This level of analysis also permits a graded sequence of simulations which range from those with few irrelevant distractions and complexity through those where the distractions and complexity are even greater than is normally encountered on the job.

Once the task has been encoded as a model, it can be validated by doing quick tryouts using a novice to perform the task, and changed as inadequacies are discovered. This procedure may even clarify aspects of the procedure for the exemplar performer who never understood why a particular action was performed -- only that it worked. Documenting aspects of job performance with a video camera instead of only a task list (verbal representation) is another possibility that is consistent with eventual presentation via videodisc.

Another possible addition in Block I.1 is an analysis of the system to be trained as well as the job of the operator, maintainer, or other user. Interactive videodisc is used increasingly to provide simulations so the user can practice doing the job rather than reading about it or seeing it done.

Linear procedure simulations present a fixed sequence of videodisc or computer-generated frames. There is only one path through the material. This approach is excellent for providing instruction and practice on startup, alignment, and other fixed or invariant procedures. However, troubleshooting, supervisory training, counselling, and many other types of interactions require a non-linear or multi-dimensional model of the system being simulated -- a piece of hardware, a paranoid patient, or an economy,

for example. The possibility and need for such a model arises in a system simulation, which can now be widely available with interactive videodisc.

The simulations on interactive videodisc also make possible graded practice starting with simple tasks and no distractions or difficulties, and progressing successively through emergencies and other situations that are more difficult than usually encountered in actual practice. The task analysis therefore needs to also describe the full range of interfering conditions that make up the job.

I.2 Select Tasks for Training

This block is not significantly affected by the new delivery system except in cases where some higher level tasks were eliminated from training due to inadequate training equipment or facilities. Use of the interactive videodisc may permit simulations of these higher level tasks and thus their inclusion in the training program.

I.3 Construct Job Performance Measures

This block is affected primarily at Step 2.3: Determine Simulation Requirements. It is possible to add two-dimensional simulation models for better fidelity during testing. This increases standardization and exportability, and may permit a more job-like measure to be taken during training. In addition, item generators can be added for tests in order to provide greater security, and computer-generated overlays can be added to the high fidelity pictures to increase realism. Computerized Adaptive Testing (CAT) can be used.

I.4 Analyze Existing Courses

The purpose of this block is to take advantage of prior analyses conducted for other courses. If a more flexible delivery system permits inclusion of new tasks or requires a more comprehensive analysis, the requrements for accepting the analysis performed for another course may change. Otherwise there is no effect on this block.

I.5 Select Instructional Setting

One of the effects of the new delivery system is to permit more tasks to be trained through self-teaching exportable packages (STEP's). By exporting training in this form, schools and other less formal learning centers can provide high quality instruction, including simulations. Moreover, where a task is a high criticality item for immediate performance when the soldier arrives in the field, a common training package can be prepared for use at schools which will then also be used for refresher courses in the field.

As a generic information delivery system, the interactive videodisc permits much greater clustering of tasks than is possible with other delivery systems. It also permits self-teaching exportable packages, formal on-the-job training, and school training

to make use of the same training packages.

A ruggedized or militarized version of an electronic information delivery system can also be used for job aids, to provide graphics and text. A number of these job aiding devices are being developed at the present. They permit the enormous complexity and volume of a maintenance manual to be compressed much more than with paper. The volume can be effectively hidden from the student, since only that part required for a particular operation is presented as needed. They can also simplify access to large maintenance manuals in cramped quarters by replacing the large open book with a single television monitor. In time, intelligent job aids which include an expert problem solving program may be available to maintenance personnel. This expert function corresponds to a built-in test equipment system, but can be added after the equipment is already in place. It can also make use of the flexibility of a human maintenance person to diagnose and solve problems.

In selecting items for self-teaching exportable packages, it should be noted that IPISD Guideline 2 in Block I.5, which requires that everything be included in the package, can be more easily met with an interactive videodisc system.

As part of the packages that are developed for formal on-the-job training, a provision needs to be made for non-commissioned officer (NCO) training. At present, most of the TEC lessons are used by NCO's for a refresher prior to the NCO giving a lecture on the material. If NCO training were included as part of the package, the NCO might be more open to making the rest of the package available to the soldiers directly.

II. Design

II.1 Develop Objectives

This block is affected in an important way because it is now possible through the simulations available on an interactive videodisc to write more objectives requiring job-like performance than was possible with other media. For example, in an electronic maintenance task, the objective may be to troubleshoot a problem within a certain circuit. In the past, the school portion of the training required objectives like "state the procedure to troubleshoot the ---." Using a two dimensional simulation, the objective can be "troubleshoot the ---." This is a remarkable new capability that can significantly enhance training productivity.

II.2 Develop Tests

With the integrated training and testing package available on an interactive videodisc, writing item generators and simulations is an important part of writing instruction. Tests can become performance tests in many cases. Moreover, with the computer, one can rapidly evaluate the tests and improve them. Generation of test items by the computer or selection of items for a test from a large

number of items in a pool can contribute substantially to test security. The computer can automatically score the student's test and provide immediate feedback rather than the delay commonly encountered in many testing systems. The computer can also be used as a computer-managed instruction system where the NCO enters scores on performance ratings. Attitude questionnaire and NCO reports can also be added to this data base.

II.3 Describe Entry Behavior

In order to determine the entering behavior of the students, computerized adaptive testing and synthetic job tests may be developed on the computer and videodisc system. Where the focus is on productivity in the actual job situation, this form of testing may permit greater validity in assessing student's entering skills and behaviors than would written tests.

In determining sequence and structure, the notion of increasingly complex models comes into play. Rather than asking for a verbal approximation to a hands-on behavior, it is possible to begin the student with a very simple version of the actual procedure (termed a work model), then to successively complicate the procedure until it is close to that of the the actual job. At the present, course sequencing is largely a matter of sometimes arbitrary decisions about prerequisite skills. By focusing on actual job performance, the sequence of the course can be revised based upon performance of the students in the simulations.

For example, suppose a course in calling for artillery fire required the student to learn how to spot incoming rounds in terms of their relation to the target, prior to calling for artillery fire corrections. Suppose, moreover, that this led to a great deal of confusion on the part of the students because spotting and corrections are very closely related but reverse the order of elements in the call for fire. Finally, suppose that students who were never taught spotting learned to call in corrections much more quickly and accurately than those who had been taught spotting. The simulation may permit instructors to more quickly observe these difficulties on the part of their students than would be the case where the student learns the procedure from a book and then later goes to the field to practice it.

III. Develop Instruction

III.1 Specify Learning Events/Activities

Part of determining strategy in IPISD is to categorize the objectives into a set of eleven categories, each of which uses a prescribed mode of instruction. In essence, the eleven categories provide a set of job aids for authors. These job aids can also be included in a computerized authoring system. Thus for rule learning, pools of problems can be developed for a student to practice. Examples and non-example items can be presented for classification behavior, while for symbol learning the symbols can be paired using mnemonics and standard paired associate learning

models. Detection behavior can be enhanced using a simulation or generated items in which the signal is embedded in increasing amounts of noise.

Gross motor behaviors can be partly trained using a two dimensional simulation to demonstrate and model the behavior. For example, a demonstration can be given for cutting a complex pattern on a lathe, by showing the cuts on the videodisc and permitting the student to examine them in slow motion. In this way the critical features can be highlighted for the student's attention.

Finally in the area of attitude learning, a human model can be presented by the videodisc. Modeling has been shown to provide the most effective means of changing attitudes. If necessary, the student can interact in a limited way with the human model on the videodisc by responding to questions, where the human model's feedback on the videodisc depends upon the reply of the student. Videodisc simulations using human models can help in training supervisors and counselors.

III.2 Specify Instructional Management Plan and Delivery System

The Instructional Management Plan usually calls for information gathering, and development of a data base. The computer component of the interactive videodisc system may include a computer-managed instruction (CMI) program which greatly facilitates this effort. If so, it should be designed early in the process.

Block III.2 also calls for specification of the delivery system (media selection). With a flexible delivery system like the interactive videodisc, the issue is not so much which medium will be used, since this one delivery system can provide virtually all the capabilities of print, slide/tape and videotape. Rather, the issue is how best to use the interactivity and creative possibilities of this new delivery system.

III.3 Review/Select Existing Materials

One of the prime advantages of the interactive videodisc system is that it permits widely diversified materials to be combined into a single program. For example, if two videotape productions on the same topic use different actors, different equipment, and have different color balance they may still be used in a videodisc by inserting still frame text and graphic sections between the videotape segments. Existing graphics may also be used, as may portions of training films. Therefore more existing materials are likely to be usable with this system.

III.4 Develop Instruction

Most of the steps in this block are not affected to a great degree by interactive videodisc capbility. However, IPISD section 2.3.4, "The Audio-Visual Production," is greatly expanded upon in the Workshop Guide. In that Guide, Module 2 describes "Design and Authoring," including design of text and graphic formats, the

computer program, storyboards and orientation material, and special effects and animation. All are oriented specifically to interactive videodisc.

Module 3, "Preproduction," in the Workshop Guide provides details on how to prepare production lists/scripts, select available masters, select the talent and music, layout the disc geography, and plan the production.

Module 4, "Production," describes production of video text frames, animations, art, photographs, print, location video, studio video and audio, and the computer program. Special attention is given to the use of video still frames.

Module 5, "Post-Production/Pre-Mastering," provides procedures for conducting off-line edits, making the master tape, and entering the videodisc computer program.

Module 6, "Mastering," describes lessons learned and procedures for obtaining good mastering and for integrating the computer program with the videodisc.

Guidelines for designing interactive videodiscs to use touch panels and voice input are presented in the workshop appendices.

III.5 Validate Instruction

Validations for interactive videodisc programs are conducted using paper storyboards, the video character generator, and in a few cases with a computer-controlled videotape facility as well as videodisc. Because of the expense involved, it is not wise to conduct initial trials on the videodisc itself. Where a high proportion of instruction is of workbook or programmed instruction format, the storyboard may be adequate for conducting initial validations. Where more complex interactions are required, the student may use the video character generator which permits computer control as well as integration of external video components. Computer-controlled videotape can be expensive and unwieldy. In some cases a simulation which combines videodisc with computer-generated overlays might be validated by using the computer program to generate the overlays and using pictures or a live TV camera to feed in the external video image. Simulations are very difficult to validate without the videodisc.

IV. Implement

IV.1 Implement Instructional Management Plan

The interactive videodisc is an aid to the NCO and to the commander. Nevertheless, they will need to learn how to use this new tool. To the extent that the instructional management plan calls for instructors to serve as advisors and models rather than readers of lecture notes, staff roles will change. The implementation phase is not the time to begin the staff liason. Instead, instructors need to help design the new training program.

IV.2 Conduct Instruction

In Step 2.2: "Obtain Required Training," the instructor prepares for test administration and other instructor roles. In this step it is important to emphasize that the instructor will evaluate performance that cannot be measured with the two-dimensional simulation. An example is a psychomotor task like landing an airplane.

V. Control (Evaluate/Revise)

V.1 Conduct Internal Evaluation

Since data can be collected continuously by the computer and presented in a straightforward report format as part of a computer-managed instruction system, the conduct of both internal and external evaluations can be simplified. Basic statistics can be available on demand for each student and for groups of students. If the authoring language does not provide this capability as a built-in function, it may be developed as part of the fielded program. Care should be taken not to burden instructors or users with new forms and data requirements, since these new requirements will likely be ignored. If an existing manual data collection system works well, use it.

V.2 Conduct External Evaluation

The only change in this block is that which was noted above in V.1.

V.3 Revise System

The critical importance of computer-generated graphics and text overlays for revising the videodisc has been described above. In the approximately 54,000 frames available on one side of a videodisc there are many opportunities to include stills and motion sequences which are unusable. It would be unreasonable to expect instruction developers to produce each one of these frames without error, and it would also be unreasonable to expect that over a period of many months there would be no changes in operational procedures. The interactive videodisc minimizes this problem because the computer program can be rapidly modified and thereby significantly extend the life of the videodisc program.

THE "CALL FOR FIRE" PROGRAM

During an extensive examination of videodisc costs in relation to alternative delivery systems (Bunderson and Jarvis, 1979), it became clear that the capability of an interactive videodisc to generate new problems or to select randomly among a larger number of items has very high cost savings potential. This is because generative test items do not require frequent updates in order to maintain test security. Moreover, a few test formats can be used to generate a very large number of actual test items, so that alternate forms of the test are not required. Also, as a part of that study, it was discovered that a relatively small common core of subjects is used very widely throughout the Army (e.g., first aid, military courtesy, and other subjects common to all Military Occupational Specialties--MOS's, plus call for fire, basic radio operation, etc., common to several MOS's). If training packages for these common tasks could be prepared and combined with the related Skill Qualification Tests, each package would have a very large number of potential users. This is one of several potential sources for dramatic cost savings.

On the interactive videodiscs produced during this project, there is a combination of both the cost savings potential of generative items and the cost savings potential of job training packages to produce an integrated training and testing package.

The Call For Fire videodisc contains six Call For Fire TEC lessons, portions of three SQT tests with generative items, portions of six videotapes, a series of simulations and games and an executive summary. The following sections present the major packing procedure and major components included on this disc.

Packing Procedures

The material on this one disc can provide a common core of training and testing for several MOS's. The disc exceeds the packing density estimated in an earlier study (Bunderson and Jarvis, 1979). The higher density is another potential source of significant cost savings.

One of the most important features of the original TEC lessons is the amount of redundancy. Each lesson depends upon those before it. In many cases, lessons repeat material from earlier lessons. On the videodisc, it was possible to record the core material once, then to branch back to that material as required in subsequent lessons. This saved a considerable amount of space on the disc in relation to that required for the TEC lessons.

To illustrate the packing accomplished, one videodisc with approximately 30 minutes of video running time contains information equivalent to six TEC lessons running 30-40 minutes each, in addition to the SQT tests, videotape motion segments, simulations, executive review, and authoring examples. The use of one videodisc segment to accomplish several purposes is one of the primary factors

in this packing.

Another factor is the use of both audio channels. Current videodiscs and players do not yet offer still frame audio. It is necessary to use 30 frames per second in order to record audio. By recording part of an audio message on audio channel one, then doubling back and repeating the remainder of the message on audio channel two, it is possible in some cases to double the effective audio time on the disc. Naturally, this technique works only where the same visual is appropriate for both audio tracks. It was used in this effort to simulate still frame audio. In practice, we discovered that use of both audio tracks in this manner increases production complexity and results in long pauses while the player plays backward to pick up the second audio track. Therefore, while it demonstrates a capability, it is not recommended as a standard practice. However, two separate audio tracks related to the same visual can be very efficient. The second audio track can also be used for a second language, stereo sound, random access audio for computer-generated displays, or digital programming information.

Training Extension Course (TEC) Lessons

TEC lessons are widely disseminated in the Army, Army Reserve, and Reserve Officer's Training Corps (ROTC) units. They provide exported training for basic and advanced military skills.

One of these skills is calling in artillery fire, by which a forward observer gives the location of a target, then adjusts the firing as rounds impact near the target.

The six TEC lessons used for this videodisc form an integrated series which take the student from simple determination of direction skills (using the North star, compass, a watch, and other field expedients) through actual Call For Fire skills and subsequent adjustment of fire. The intention was to illustrate the range of presentation strategies and interactive features, and to fully exercise those possibilities. The aim was not to correct any instructional deficiencies in these existing TEC lessons. The TEC lessons were produced several years ago, and were some of the first in the series. A number of procedures had changed in the interim (e.g., in communications), and these were corrected during the reviews with subject matter experts at the U.S. Army Field Artillery School (USAFAS) at Ft. Sill. On the other hand, there was no attempt to reanalyze and redesign the content.

Skill Qualification Tests (SQT's)

SQT's test the ability of individual soldiers to perform the tasks associated with jobs.

The Call For Fire portions of infantry, armor, and artillery MOS's are included on this videodisc. That is, the same generative items that are tested in the SQT tests are included as part of the instruction. This insures test security while providing realistic practice to the students. Generative items were of two types:

graphic and numeric. Generated graphics were used to overlay targets on videodisc images of maps or scenes as if they were viewed through binoculars. Numeric items were generated for the adjustment phase of the call for fire procedure.

The ability to generate items for SQT tests considerably enhances test security, and alleviates the necessity of producing new versions of the test at frequent intervals. The same feature of generative items means that a student can practice on questions which have the same form as the actual test, but with different parameters. Just as the parameters are filled in to create new practice items, they are filled in to create new test items. By using the computer, literally millions of problems and combinations can be created, each of which fits the specified requirements for content and difficulty.

By using generative practice tests, students are able to practice the critical skills to be learned. The same software controls both actual and practice tests. In fact, the generative items can be used to produce not only instruction items and actual test items, but also practice test items, and the same coding will suffice. The cost savings potential of this use of generative items is considerable. It means that for many questions, soldiers will be able to practice for an SQT by taking a highly similar test and not compromising the integrity of the actual test.

Videotape Productions

One of the questions to be answered by this study was how video motion segments from existing educational television lessons could be incorporated into the videodisc system. It is quite easy, once desirable footage has been located.

Two types of videotape segments were used for the Call For Fire videodisc. The first was "action shots" of targets, artillery fire, and the like. The second was an extensive Call For Fire interchange between a unit in the field and the Fire Direction Center. In this way, the students are able to get a feel for the actual environment in which they will be operating, and also they see an excellent model of the skills they will be learning. This modeling of skilled performance is a critical ingredient in many training applications.

Two factors are especially important about the use of videotape for videodisc work. The first is that new motion segments typically cost two to four thousand dollars per minute to produce commercially. Thus, motion segments can dramatically increase the cost of videodisc-based training. However, by judiciously selecting motion clips from the wide variety of videotapes provided at the Field Artillery School, it was possible to meet all of the motion needs without shooting any new footage.

The second factor in the use of videotape for videodisc work is that one can draw from a wide variety of videotape programs, and combine motion shots using different actors, different settings, and even different color balance. Since the motion segments were

surrounded by still frames and by audio-over-text which were generated, the student never encountered the transitions that can occur when motion sequences are edited together from different sources. We also tried an experiment of dubbing in new audio dialogue over the old Call For Fire motion segments. While it was difficult to achieve lip sync, for instructional purposes the materials showed the student what an actual Call For Fire looks like using the most current procedures. This was accomplished without any reshooting.

Simulations and Games

It was decided to exercise the computer to generate new problems for an additional portion of the SQT test on Call For Fire. Therefore, for research purposes, an armored vehicle recognition exercise was added. It is similar to the recognition exercises for aircraft, ships, and even semaphore signals used in the other services.

The Call For Fire simulations can be presented as games to increase student interest and motivation. They are essentially the same as the actual SQT test items, the SQT practice items, and the instruction, except the simulation provides an interesting, integrated, motivating context for the discrete test questions.

Executive Review

The executive review is a summary of the contents for each of the major components of the videodisc. It can be selected from the initial menu and illustrates different question types, motion segments, generative items, and the like. Since the executive review is entirely under program control, it can be modified to emphasize different portions of the training/testing materials.

Authoring Guide

By utilizing a different computer program, the disc can be used to illustrate a number of different authoring possibilities. There are still frames on the disc as aids to authors, and these can be accessed by an authoring program. In essence, the executive review and the authoring examples are simply different selections of materials from the videodisc, oriented to the needs and interests of executives and authors, respectively. Computer control of the disc, combined with graphic overwrite capability, allows other selections to be programmed after the disc is mastered.

The components on this disc provide examples for authors to use, and a source of ideas for how an interactive videodisc might be constructed.

Voice and Keypad Inputs

The Call For Fire procedures were much more interesting to soldiers when they were actually doing the call for fire in a simulation than when they were seeing a TEC-like presentation.

However, during simulations students were hampered by the amount of time it took to type in their responses. Therefore, two other input modes for the Call For Fire simulation were introduced.

Voice Input. Call For Fire is usually accomplished by the forward observer using radio or telephone communication. A natural interface between the user and the videodisc simulation was voice input. Using this system the soldier is presented with a target as it appears through binoculars, including the sighting reticle. The target is identified at the center of the reticle, and the location of the first round that hits near the target is specified. The soldier must then spot (call in the location of) the first round, and then call the corrections. Subsequent rounds are then shown, with the soldier calling in corrections until the rounds land within a prescribed area of the target. The soldier then calls in, "fire for effect." This is followed by a motion sequence of explosions destroying a target. This approach has produced very high interest. The workshop guide (Campbell, Tuttle, and Gibbons, 1982) presents an extensive description of the voice input.

Keypad Input. As an aid to the student, a special purpose keypad, where keys are labeled "LEFT," "RIGHT," "ADD," "DROP," "FIRE FOR EFFECT," etc., was adopted. This capability is much easier than typing. The labeled function keys also provided cues to users who were just learning the protocols for Call For Fire. A keypad is an inexpensive alternative to voice input, but lacks the authenticity of actual job performance provided by voice input.

THE RT 524 ALIGNMENT SIMULATION PROGRAM

Training Army Personnel

Personnel at Ft. Gordon were already well versed in videodisc production procedures. However, they tended to specialize in equipment simulations, and have developed a number of procedures that are optimized for that type of application. The revised procedures presented in the accompanying workshop reflect the lessons learned from their experience.

A workshop was given to Ft. Gordon personnel to acquaint them with the procedures. These procedures were then used and adapted by the Ft. Gordon personnel to make the RT 524 alignment program.

RT 524 Alignment Simulation

The RT 524 simulation was produced by Ft. Gordon personnel. They were provided a task analysis verification, a workshop on the procedures, and consultation on the videodisc. They were also provided an authoring system and programming capability for the videodisc, together with the delivery system hardware. They did all of the authoring, video production, and tryout in an actual course.

The RT 524 alignment was chosen because the Ft. Gordon personnel were familiar with equipment simulations, it involves one of the most common pieces of equipment in the armed services, the alignment skill is frequently needed and is critical, and because a new videotape series was available presenting a motion sequence of an expert's model for the alignment procedure.

After the task analysis was complete, the subject matter expert, working with instructors in the course, revised the procedure guide to reflect the new test equipment used in the course and minor changes that had been made in the procedure. A set of production sheets were then developed to guide the shooting of the stills used in the simulation. It was decided to shoot a resource library of every control and every indicator in every position on every piece of equipment used in the alignment. Each of these stills was shot using a studio quality video camera and transferred immediately to an ESS-2 still frame store. This device stores individual video frames magnetically so they can be edited in any order then transferred as a block to videotape. With a still frame storage device, individual frames can be captured without the time-consuming process of editing them one by one onto tape. Character generator text was similarly transferred to the still frame store.

During this phase of production four important lessons were learned:

- Production sheets for still frames should be optimized for the content rather than using a storyboard format. For example, when shooting stills for an equipment simulation, it is much

easier to copy a photograph of each piece of equipment on a separate set of authoring forms and to simply circle the control or indicator that the student is to use, than to create a verbal description of the action the student is to take during each portion of the simulation. Figure 2 presents an example of such a form.

- In linear, fixed-procedure simulations, it is much more efficient to organize the stills in the sequence in which they will be used than to create a general purpose resource library of stills of every control and indicator for every piece of equipment. While the videodisc player can easily seek out the stills as they are required anywhere in this resource library, it is much more difficult for the author to search through the videotape finding the appropriate stills, and for the programmer to see what is going on in the simulation. Videodisc search time during the simulation also takes longer.

- There is usually higher payoff from selecting a small volume of content and doing it very well than selecting a large section of content for first efforts using a new videodisc procedure. The RT 524 simulation has been enthusiastically received in the RT 524 alignment course at Ft. Gordon, and an initial evaluation indicates it is effective. However, a huge amount of work was required to put together the comprehensive interactive videodisc program, partly because it covers so many procedures.

- A content area should be selected that will allow users to do something they could not do without the videodisc simulation. For example, during the alignment procedure in the course students are never allowed to adjust the tuning coils with a feeler gauge and stick because constant adjustment would break the coils. The simulation allows students to practice this without harm to the radios. As another example, students can practice via simulation the procedures they are normally prevented from doing on high voltage circuits because of the danger involved.

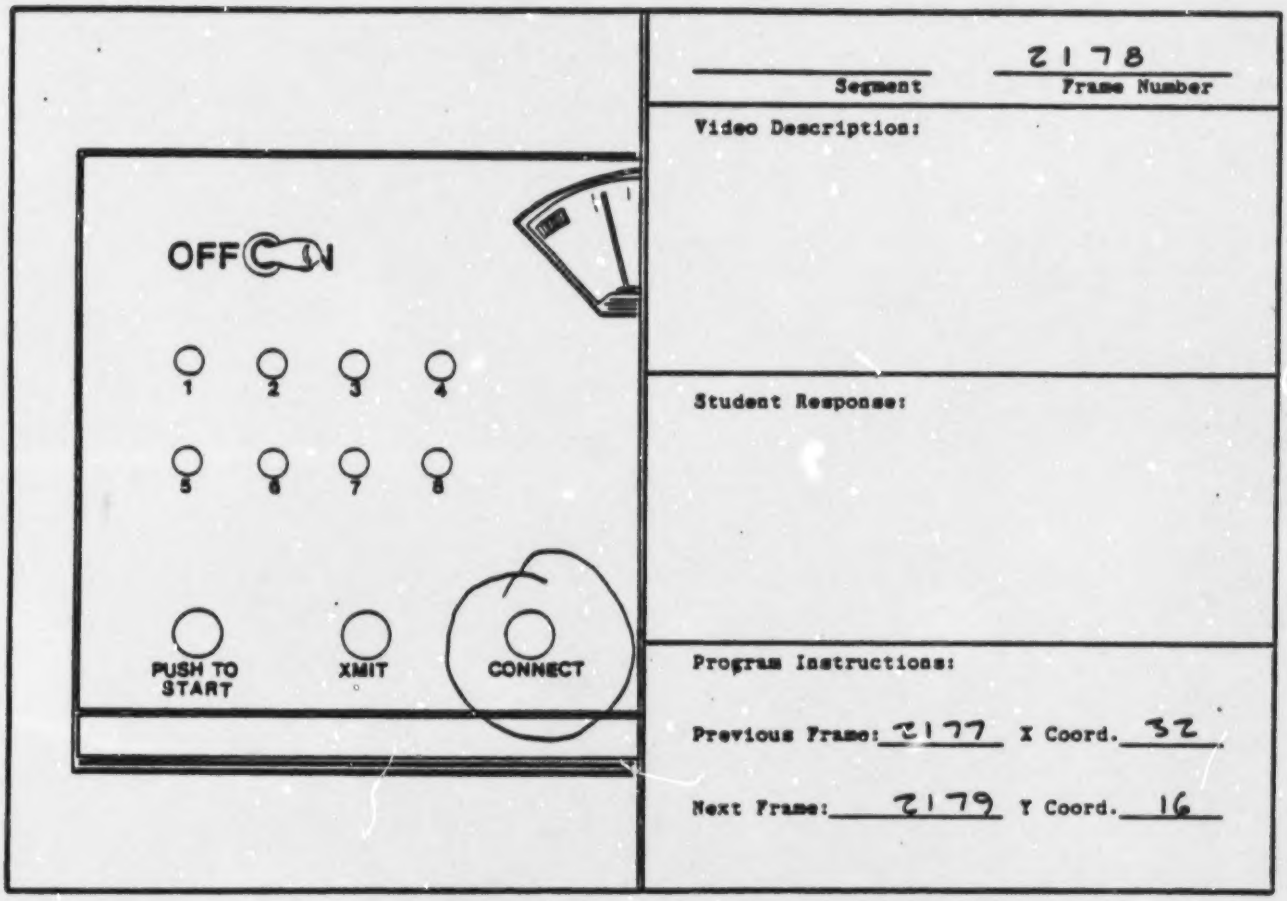


Figure 2. Sample production sheet for a linear equipment simulation. (Adapted with permission from those used by the Ft. Gordon videodisc/microprocessor team.)

The RT 524 alignment videodisc includes the following components:

- Instruction
- Simulation
- Job Aid
- Simulated Skill Qualification Test (SQT)
- Glossary
- Overview
- Logon
- Registration
- Reports
- Touch Panel Calibration

The RT 524 alignment videodisc consists of motion sequences of an expert demonstrating the procedure, together with stills showing various controls and indicators on the radio and test equipment. Instructors can register students to use the course, and can obtain reports on either the class or individual students. Students use a touch panel for interacting to set controls and take readings.

When a student logs on he or she is presented with a menu. Instruction consists of an expert's demonstration followed by a practice section using the simulation for each substep of the procedure. At any time during the simulation the student can request to see the expert demonstration again, the glossary, or to exit. In the simulation the student follows the printed procedure guide and, using the touch panel, sets controls, attaches test leads, and takes readings from indicators. The expert, glossary, and exit options are always available. This simulation mode is preferred by the instructors.

The job aid presents the expert's demonstration as a series of discrete actions. The user observes the expert demonstration for an action, performs that action on the radio, then touches the screen to go on to the next action. The simulated SQT is the same as simulation mode except that an instructor can select any step from the alignment procedure for the student to perform, and no expert or glossary help is available.

The glossary presents a short verbal and graphic description of each module of the radio, together with its function. Test points are labelled. In order for the legends to be legible, the student can touch one portion of a graphic and "zoom in" on it. The overview is a motivational introduction to the program that describes the importance of proper alignment procedures. Logon is

accomplished by entering via touchpanel the digits of a personal identification number. The system presents either the student or instructor menu, depending on user status. Instructors use the registration utility to enroll or delete users. It requires the keyboard on the instructor terminal. Reports provide the instructor with either a class list or detailed information for an individual. Touch panel calibration permits the instructor to calibrate the physical touch panel to a particular television monitor.

Delivery System Hardware

The delivery system for the Ft. Gordon simulation consists of a microcomputer containing a 16-bit processor, 256K of RAM, dual 8 inch floppy disk drives with 1.2 Mbytes each, and a videodisc control and overlay board. To this central computer are attached an instructor terminal (CRT) with keyboard, the touch panel, the videodisc player, a television monitor, and a tone generator that is used during the alignment. This hardware is an example of general-purpose delivery systems that can support a wide variety of simulations and instruction. While the great majority of interactions use the touch panel, the instructor terminal is very useful for performing system backups, setting the system clock, monitoring which step and substep a student is performing, and registering students where names and other textual information must be entered. The instructor terminal consists of a CRT with standard keyboard. It is used only occasionally and can be moved from one system to another.

Authoring System

Because the touch panel, instructor terminal, and tone generator could all be used simultaneously, an off-the-shelf authoring system was not used. Instead a custom authoring system was developed. After the author and programmer have developed a detailed set of functional specifications for each of the functions in the program, the programmer produces a set of templates and drivers. These are simply forms for each type of interaction. Using them, authors and instructors can easily create and modify the interactive videodisc program. Some of the templates are discussed below.

The Motion Template. The motion template asks for the first videodisc frame to be presented, the last frame of the motion sequence, whether any graphics on the screen should be erased from a previous template, and the template to branch to next.

Still-Touchpanel Template. Another template allows the author to specify touch panel locations of anticipated student responses. A videodisc or computer-generated frame is displayed on the television monitor. If it is a videodisc frame, the author specifies it as part of the touch panel template. If computer-generated text will be used, it is specified in a previous template and the touch panel template does not erase the graphics from that template. The author indicates touch panel locations by touching the top left and bottom right of an area on the screen. A

computer-generated box is drawn around this area so the author can visualize the response area. The box is not presented to students. Next the author types in the number of the template to which the program should branch if that location is touched by the user. These touch locations can be erased, and the branches can be easily changed.

Other Templates. Other templates for the RT524 alignment simulation allow the author to create computer-generated text, and two types of meter adjustments.

The motion, computer-generated text, and touch panel templates were available from other programs and were easily adapted. The two types of meter templates were created new for this simulation.

Once the programmer has created the templates and mini-drivers so that the author can observe the results of filling in the templates, the programmer then creates the course drivers that call the templates, handle interrupts, and provide logon, registration, reports, and the like.

Because the usual still frame store operators at Ft. Gordon were out of town during most of the RT 524 video production, it was not possible to put touch panel legends at the bottom of the video picture. These legends allow the user to select the glossary, expert, or exit options. Therefore, the course drivers used computer-generated text to overlay these legends on the videodisc images.

Once the programmer completed the first pass of creating the templates and drivers, the authors were very quickly able to enter the data and try out the program. This approach to authoring provides the flexibility of hand-programmed code to run multiple inputs and outputs, create special purpose interactions (e.g., the meter adjustments) and provide for program interrupts (e.g., glossary, expert, and exit options at any point in the simulation). At the same time, the approach permits authors who have no knowledge of programming to quickly enter their data, try out the program, and modify it based on what they see. This is an invaluable asset, and means that personnel in the field can maintain their own programs without relying on outside expertise for modifications.

Evaluation Results

This project included two evaluations during the third year: A formative evaluation of the process of making the videodisc, and a field evaluation of the completed program. The results of both of these evaluations are reflected in the workshop procedures.

Many of the following observations and recommendations are from Ft. Gordon personnel, based on this and other experience producing videodisc programs.

Formative Evaluation.

- One of the most important lessons learned during this project is that military personnel frequently are re-assigned, and interactive videodisc production in the military must be based upon written agreements. Many of the military personnel on the project were replaced during the time the videodisc production was in process. This resulted in the reversal of a number of decisions, and some considerable consternation as the new team leader worked out solutions while living within the boundaries of decisions made earlier. A clear road map and agreement is needed early in the project for the type and amount of training to be produced, what type and amount of resources will be committed, and the basic strategy to be used for the project. User requirements and functional specifications developed early in the project as design guides are critical elements of continuity in this situation.

- Time spent up front designing the forms and procedures to be used is highly leveraged: A little time spent planning and designing produces large savings at the end, when production and post-production costs are high. Avoid paper work, combine forms, and simplify as much as possible.

- Another lesson learned is that the storyboard format used for motion sequences and certain stills is not efficient for describing a sequence of actions performed on a piece of equipment. In the latter case, a simple photograph of the face of the equipment or of the test points to be checked can be copied onto a form and the appropriate controls, indicators, and test points annotated in sequence. This provides a very concise guide for shooting simulation stills. Since no audio is required, this abbreviated form is both adequate and efficient for linear equipment simulations.

- During the formative evaluation it was discovered that shooting a resource library of every control and indicator in every position on every piece of equipment is extremely time consuming and frustrating. If it is efficient to shoot the equipment in the sequence of the maintenance procedure, this is the best method to use. If a troubleshooting simulation or a non-linear procedure will permit the student to branch to any piece of equipment and set any control or examine any indicator, then an approach closer to the resource library is appropriate. However, it is not recommended that one shoot every possible configuration, and it is recommended that all video equipment stills be carefully organized and catalogued to facilitate locating them on the videotape when the author specifies the sequence of frames to be used. If the frames are in linear sequence, it is simple for the author or programmer to find each frame of the procedure on videotape or videodisc.

- A simulation like the RT 524 uses a very large number of stills. These can come from slides, videotape, or video transferred directly to a still frame store. Ft. Gordon uses an ESS-2 still frame store, and thus records the equipment stills directly on this device from camera. The stills can then be transferred at the standard 30 frames per second to a videotape. However, because the still frame store cannot be synchronized with the videotape, and because they used quad tape format, it was impossible by viewing the tape to tell whether a sequence of stills began in field 1 or field 2. As long as there is only one dump of stills and the rest of a videodisc side is motion, there is no problem, since the dominant field of the stills can be detected during off-line editing and specified to the mastering facility as a dominant field for the entire side of the videodisc. This means that the motion sequences may not have the proper field relationships, but this is largely irrelevant for motion, since the edits flash by so quickly, and motion sequences within an edit usually consist of frames that are nearly identical. Alternatively, if a helical format tape is used, the dump of stills from the still frame store can be repeated until the tape shows that the dump begins in the proper field.

- An expert demonstration for the RT 524 alignment was already available as a motion videotape that was used in the alignment course. If a new expert demonstration is required, it should be scripted on standard storyboard sheets.

- During the course of this contract, outside programming support was provided to Ft. Gordon personnel. This raises the issue of programming support for an extensive program. Contract programmer, General Services Administration (GSA) programming, in-house programmers, and a full-feature authoring system are all possible responses to the problem of programming required. The graphic support from the Training Aids Support Office (TASO) on base and video support from the Ft. Gordon television studio were both quite good. Most other groups within the armed services will be able to find graphics and video support. It is the <u>programming</u> that is usually in shortest supply.

- Subject matter expert support was excellent for this program, and it is imperative to get the <u>best</u> person in the shop to review and if possible to write the training materials. The video shots from the television studio should then be checked against the procedure using a dry run simulation on videotape if possible. It is also useful to have someone not associated with the videodisc program conduct an independent verification of the procedure using the videotape.

- For the portions of the videodisc that are equipment-related stills, the scripting sheets containing annotated graphics of the equipment become the shot sheets for video production and the programming guides as well. This is especially the case if the video stills can be shot in the sequence of the procedure. Even in the case of a troubleshooting or non-linear simulation, it may be possible to create linear problems where a symptom is presented and the student is allowed to follow only one path to the correct solution. If this simplifying assumption can be made, all of the interactive videodisc work from scripting through video production can be greatly facilitated.

- It is important to be able to overlay computer-generated graphics and text on the videodisc image. Using the inexpensive TI9918 chip, these overlays tend to jitter and are only marginally acceptable. More expensive systems limit the jitter. However, it is also possible to simply switch between computer-generated text and videodisc images. In this case there is no jitter problem, an inexpensive system can be used, and most of the benefits of overlay are still available. For the RT 524 simulation, touch panel choices (EXPERT, GLOSSARY, and EXIT) were overlayed on the videodisc image.

- Implementation of the program should take place first with instructors, and over a period of time that allows them to become familiar with the program and to specify corrections if necessary. It is not uncommon to find that instructors use short cuts, whereas the interactive videodisc program uses standard procedures from the technical manual. This is likely to cause some problems, and these inconsistencies need to be remedied prior to fielding the videodisc program.

- One of the most important lessons learned is that spatial orientation can be easily lost in a two-dimensional equipment simulation. In other words, after a 2D interactive videodisc simulation the student can follow the procedure guide, but may not be able to find a particular test point or recognize a particular test cable on the actual equipment. One response is to require the student to zoom in and out for every control, indicator, and test point. This forces a spatial orientation to the equipment. However, it can become very time consuming and frustrating to the user. It is recommended that the videodisc program explicitly include spatial orientation, either as a visual tour of the equipment or as a series of exercises where the student must zoom in to find specified locations. This is sufficient where the actual equipment is well labelled and controls, indicators, and connections are easy to find. If they are not, the student should also have access to actual equipment or to physical mockups in order to learn locations and to recognize components. It is important to note that these mockups do not need to be manipulated by the student, to have voltage applied, or to be operational. The actual equipment or

mockup is simply to provide a physical and spatial orientation to the student.

- It is important to avoid undertaking a massive task for the first project. Even a 10 or 12 minute simulation can tax resources the first time through. It is better to pick smaller bites for authoring, production, and presentation to the student.

- It is valuable to attend a workshop prior to beginning production. There one can review what has been done, how it is done, obtain a common vocabulary and get hands-on experience. The Videodisc Design/Production group at the University of Nebraska conducts an excellent workshop for this purpose. The workshop guide prepared for this project is a good resource for the non-hands on aspects of videodisc development. Another resource is the two videodisc set distributed by 3M entitled, "Producing Interactive Videodiscs" (Optical Recording Project/3M, 1982). These materials were prepared by the Nebraska Videodisc Design/Production group, and include a printed guide. Attending a workshop, using a workshop guide, contacting those who are active in the field, and looking at or using different programs can make a project much more productive.

- Production of videodisc still frames is much easier with 1 inch helical scan videotape, a multi-font character generator, and a computer editor. None of these were available at Ft. Gordon for the production of the RT 524 simulation. An ESS-2 still frame store was used, however.

- It is still early in the development cycle of interactive videodiscs. It is trivial to tranfer an existing motion sequence onto videodisc, and this hardly makes use of the capabilities of the system. However, the interactive parts using still frames are quite difficult to produce and program in large numbers. That is why it is important to pick as an initial problem a small, effective, and simple task. This first experience can then be used as a building block for more advanced programs.

Field Evaluation. The field evaluation was conducted in the 31E alignment course for the RT 524 radio at Ft. Gordon. The program has received a good response in the school and the school is making arrangements to keep the simulation in the course and continue the evaluation during the next year, with the thought that the alignment simulation may be exported to other locations.

The field evaluation was conducted by school personnel. The central questions concern:

- What changes in procedure would make this type of interactive videodisc program more effective?
- What is the response of instructors to the program as a whole and to the detailed content?
- How can an interactive videodisc simulation like this best be integrated with an on-going course?

The instruments used were:

- Structured interviews with instructors.
- Check on those students who took the independent criterion test following the simulation.
- A log of student and instructor comments.

The first three students through the simulation who went directly to the testing without any hands-on experience all had difficulty on the criterion test. A detailed follow-up revealed the following:

- Students were using the new procedure guide for the alignment simulation, but were required to use the old procedure guide during testing.
- Students did not recognize the test cables used in testing. Further examination showed that one of the critical cables was specially fabricated in the course, and did not correspond to any of the cables in the testing situation.
- The students could not locate some of the test points.

The instructors in the course provided the following solutions:

- Students were permitted to take the new procedure guide to testing.
- The head instructor for the alignment section presented a brief overview of all the test cables used for the alignment.
- Graphics showing the location of each test point were introduced into the new procedure guide, and students alternated between performing each alignment step in the simulation and on the actual equipment.

With these changes students passed the criterion test on their first attempt. The instructors also reported informally that students were taking less time in the course using the simulation than they were with the former procedure of watching the videotape

presentation and then performing the alignment on the radio. It was also observed that even students who would not otherwise get the simulation were assigned to the simulation step where radio tuner coils are adjusted, since constant adjustment of the actual coils breaks them.

Instructor attitudes toward the simulation were very good, even among those who were skeptical at first.

The initial results of the field evaluation indicate that instructors can easily integrate the interactive videodisc simulation into the course, but want to be sure that students have actual hands-on experience as well as the simulation. Using the authoring system, instructors have made numerous corrections to the detailed content of the simulation. Although in an actual field setting this authoring capability would need to be limited to authorized personnel, the ability of relatively untrained instructors to make corrections without outside programming expertise is encouraging.

CONCLUSIONS

The interactive videodisc procedures presented here are based upon the Interservice Procedures for Instructional Systems Development (IPISD). This basic approach has been modified and greatly expanded, then used for a wide variety of programs. While the procedures are thus well validated, they are only general guidelines. They should be adapted for one's own application during the design phase. Most training and simulation applications will fit the model presented here rather closely. More exotic programs could require quite a different approach to authoring than the storyboards and equipment picture forms presented here. Nevertheless, the technical considerations and most of the management considerations will hold true for most any type of videodisc production.

REFERENCES

Bunderson, C.V., Campbell, J.O., & Farr, B. Videodisc Training Delivery Systems and Videodisc Authoring/Production Systems: Hardware, Software, and Procedures. Year 1, Vol. I. Army Research Institute Technical Report, No. 511, 1980a.

Bunderson, C.V., Campbell, J.O., & Farr, B. The Impact of Videodisc Training Systems on the Interservice Procedures for Instructional Systems Development. Year 1, Vol. II. Army Research Institute Technical Report, 1980b (in press).

Bunderson, C.V. & Jarvis, C.S. Evaluation of Videodisc Technology. Army Communicative Technology Office (DROCO-FE). Available only to Dept. of Defense personnel. Ft. Eustis, VA, 1979.

Campbell, J.O. & Farr, B. Authoring and Producing an Interactive Videodisc Design and Production Workshop Guide. Army Research Institute Technical Report, 1982 (in press).

Campbell, J.O., Olsen, J.B., Bunderson, C.V., Hilton, T., Wilson, B., Decker, D., & Bergstrom, S. Electronic Delivery System Presentation Features. Army Communicative Technology Office (ACTO). Ft. Eustis, VA, 1981.

Campbell, J.O., Tuttle, D.M., & Gibbons, A.S. Interactive Videodisc Design and Production Workshop Guide. Army Research Institute Technical Report, 1982 (in press).

Merrill, P. & Bunderson, C.V. Guidelines for Employing Graphics In a Videodisc Training Delivery System. Year 1, Vol. III. Army Research Institute Technical Report, 1980.

Hawkins, W.W., & Kribs, H.D. Technology For An Efficient Delivery System. Preliminary Technical Report to NAVTRAEQUIPCEN on Contract N61339-78-C-0129.

Optical Recording Project/3M. Producing Interactive Videodiscs. 223-5S 3M Center, St. Paul, MN 55144, 1982.

SALT (Society for Applied Learning Technology). Proceedings of Conference on Interactive Videodisc and Media Storage Technology in Education and Training. Orlando, FL. 1979.

Sigel, E., Schubin, M., and Merrill, P.F. Videodiscs: The Technology, the Applications, and the Future. White Plains, NY: Knowledge Industry Publications, 1980.

Stranick, F. & Sullivan, M. Study of Computer Based Videodisc Systems and the Applicability to Submarine Training. SYSCON Corporation, Newport, RI, 1982.

TRADOC (U.S. Army Training and Doctrine Command). Interservice Procedures for Instructional Systems Development (IPISD), Pamphlet 350-30, 1975.

PERIODICALS ABOUT VIDEODISCS

NEWS. Nebraska ETV Network, University of Nebraska-Lincoln, Videodisc Design, Production Group, P. O. Box 83111, Lincoln, NE 68501-3111. No Charge.

Optical Memory Newsletter, including Interactive Videodiscs. Edward S. Rothchild, P. O. Box 14817, San Francisco, CA 94114-0817. $295/yr.

Videodisc News. P. O. Box 6302, Arlington, VA 22206. $150/yr. Checks payable to Videodisc Services, Inc.

Videodisc/Videotex. Meckler Publishing, 520 Riverside Avenue, P. O. Box 405, Saugatuck Station, Westport, CT 06880. $52/yr.

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